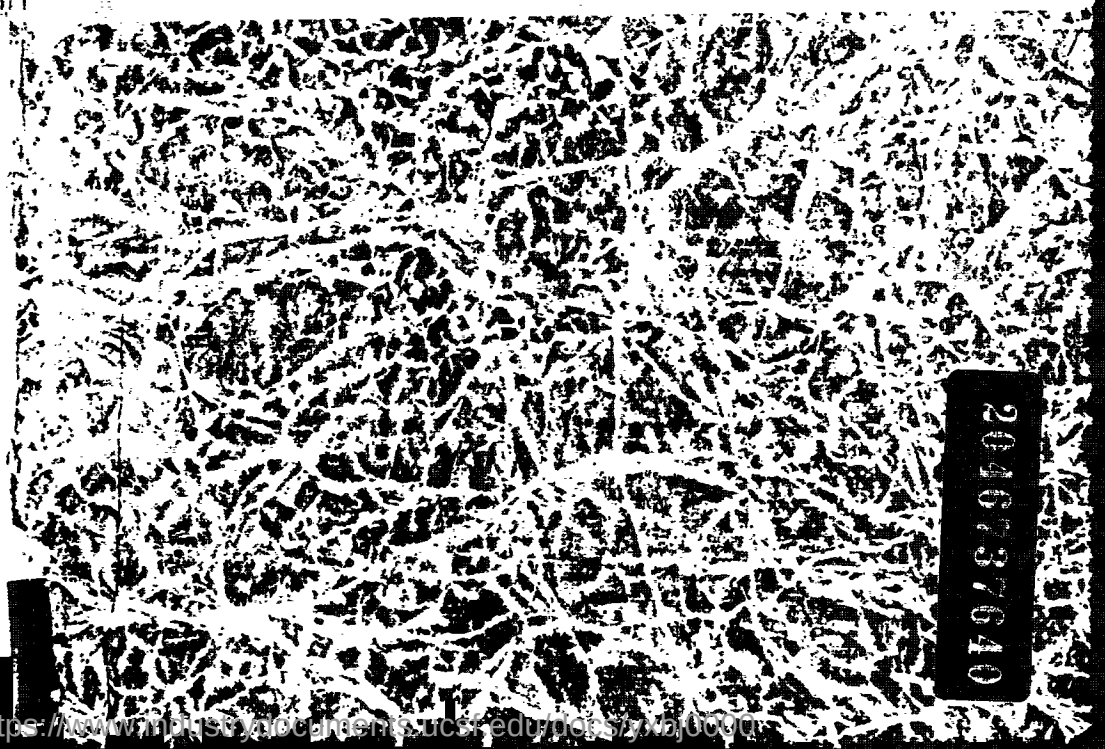
SMOKING *and* HEALTH

REPORT OF THE ADVISORY COMMITTEE
TO THE SURGEON GENERAL
OF THE PUBLIC HEALTH SERVICE

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service



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Chapter 4

Summaries and Conclusions

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Chapter 4

This chapter is presented in two sections. Section A contains background information, the gist of the Committee's findings and conclusions on tobacco and health, and an assessment of the nature and magnitude of the health hazard. Section B presents all formal conclusions adopted by the Committee and selected comments abridged from the detailed Summaries that appear in each chapter of Part II of the Report. The full scope and depth of the Committee's inquiry may be comprehended only by study of the complete Report.

A. BACKGROUND AND HIGHLIGHTS

In previous studies, the use of tobacco, especially cigarette smoking, has been causally linked to several diseases. Such use has been associated with increased deaths from lung cancer and other diseases, notably coronary artery disease, chronic bronchitis, and emphysema. These widely reported findings, which have been the cause of much public concern over the past decade, have been accepted in many countries by official health agencies, medical associations, and voluntary health organizations.

The potential hazard is great because these diseases are major causes of death and disability. In 1962, over 500,000 people in the United States died of arteriosclerotic heart disease (principally coronary artery disease), 41,000 died of lung cancer, and 15,000 died of bronchitis and emphysema.

The numbers of deaths in some important disease categories that have been reported to have a relationship with tobacco use are shown in Table 1. This table presents one aspect of the size of the potential hazard; the degree of association with the use of tobacco will be discussed later.

Another cause for concern is that deaths from some of these diseases have been increasing with great rapidity over the past few decades.

Lung cancer deaths, less than 3,000 in 1930, increased to 18,000 in 1950. In the short period since 1955, deaths from lung cancer rose from less than 27,000 to the 1962 total of 41,000. This extraordinary rise has not been recorded for cancer of any other site. While part of the rising trend for lung cancer is attributable to improvements in diagnosis and the changing age-composition and size of the population, the evidence leaves little doubt that a true increase in lung cancer has taken place.

Deaths from arteriosclerotic, coronary, and degenerative heart disease rose from 273,000 in 1940, to 396,000 in 1950, and to 578,000 in 1962.

Reported deaths from chronic bronchitis and emphysema rose from 2,300 in 1945 to 15,000 in 1962.

The changing patterns and extent of tobacco use are a pertinent aspect of the tobacco-health problem.

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TABLE 1.—*Deaths from selected disease categories, United States, 1962*

Cause of death*	Total	Males	Females
Degenerative and arteriosclerotic heart disease, including coronary disease (420, 422)	[illegible]	348,664	[illegible]
Hypertensive heart disease (440-3)	[illegible]	[illegible]	[illegible]
Cancer of lung (162-3)	[illegible]	[illegible]	[illegible]
Cirrhosis of liver (581)	[illegible]	[illegible]	[illegible]
Bronchitis and emphysema (502, 527.1)	[illegible]	12,337	[illegible]
Stomach and duodenal ulcers (540-1)	[illegible]	[illegible]	[illegible]
Cancer of bladder (181)	[illegible]	[illegible]	[illegible]
Cancer of oral cavity (140-8)	[illegible]	[illegible]	[illegible]
Cancer of esophagus (150)	[illegible]	[illegible]	[illegible]
Cancer of larynx (161)	[illegible]	[illegible]	[illegible]
All above causes	[illegible]	[illegible]	[illegible]
All other causes	1,004,027	531,477	472,550
All causes	1,756,720	994,789	[illegible]

*International Statistical Classification numbers in parentheses.

Nearly 70 million people in the United States consume tobacco regularly. Cigarette consumption in the United States has increased markedly since the turn of the Century, when per capita consumption was less than 50 cigarettes a year. Since 1910, when cigarette consumption per person (15 years and older) was 138, it rose to 1,365 in 1930, to 1,828 in 1940, to 3,322 in 1950, and to a peak of 3,986 in 1961. The 1955 Current Population Survey showed that 68 percent of the male population and 32.4 percent of the female population 18 years of age and over were regular smokers of cigarettes.

In contrast with this sharp increase in cigarette smoking, per capita use of tobacco in other forms has gone down. Per capita consumption of cigars declined from 117 in 1920 to 55 in 1962. Consumption of pipe tobacco, which reached a peak of 2½ lbs. per person in 1910, fell to a little more than half a pound per person in 1962. Use of chewing tobacco has declined from about four pounds per person in 1900 to half a pound in 1962.

The background for the Committee's study thus included much general information and findings from previous investigations which associated the increase in cigarette smoking with increased deaths in a number of major disease categories. It was in this setting that the Committee began its work to assess the nature and magnitude of the health hazard attributable to smoking.

KINDS OF EVIDENCE

In order to judge whether smoking and other tobacco uses are injurious to health or related to specific diseases, the Committee evaluated three main kinds of scientific evidence:

1. *Animal experiments.*—In numerous studies, animals have been exposed to tobacco smoke and tars, and to the various chemical compounds they contain. Seven of these compounds (polycyclic aromatic compounds) have been established as cancer-producing (carginogenic). Other substances in tobacco and smoke, though not carcinogenic themselves, promote cancer production or lower the threshold to a known carcinogen. Several toxic or irritant gases contained in tobacco smoke produce experimentally the kinds of non-cancerous damage seen in the tissues and cells of heavy smokers. This includes

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suppression of ciliary action that normally cleanses the trachea and bronchi, damage to the lung air sacs, and to mucous glands and goblet cells which produce mucus.

2. *Clinical and autopsy studies.*—Observations of thousands of patients and autopsy studies of smokers and non-smokers show that many kinds of damage to body functions and to organs, cells, and tissues occur more frequently and severely in smokers. Three kinds of cellular changes—loss of ciliated cells, thickening (more than two layers of basal cells), and presence of atypical cells—are much more common in the lining layer (epithelium) of the trachea and bronchi of cigarette smokers than of non-smokers. Some of the advanced lesions seen in the bronchi of cigarette smokers are probably premalignant. Cellular changes regularly found at autopsy in patients with chronic bronchitis are more often present in the bronchi of smokers than non-smokers. Pathological changes in the air sacs and other functional tissue of the lung (parenchyma) have a remarkably close association with past history of cigarette smoking.

3. *Population studies.*—Another kind of evidence regarding an association between smoking and disease comes from epidemiological studies.

In retrospective studies, the smoking histories of persons with a specified disease (for example, lung cancer) are compared with those of appropriate control groups without the disease. For lung cancer alone, 29 such retrospective studies have been made in recent years. Despite many variations in design and method, all but one (which dealt with females) showed that proportionately more cigarette smokers are found among the lung cancer patients than in the control populations without lung cancer.

Extensive retrospective studies of the prevalence of specific symptoms and signs—chronic cough, sputum production, breathlessness, chest illness, and decreased lung function—consistently show that these occur more often in cigarette smokers than in non-smokers. Some of these signs and symptoms are the clinical expressions of chronic bronchitis, and some are associated more with emphysema; in general, they increase with amount of smoking and decrease after cessation of smoking.

Another type of epidemiological evidence on the relation of smoking and mortality comes from seven prospective studies which have been conducted since 1951. In these studies, large numbers of men answered questions about their smoking or non-smoking habits. Death certificates have been obtained for those who died since entering the studies, permitting total death rates and death rates by cause to be computed for smokers of various types as well as for non-smokers. The prospective studies thus add several important dimensions to information on the smoking-health problem. Their data permit direct comparisons of the death rates of smokers and non-smokers, both overall and for individual causes of death, and indicate the strength of the association between smoking and specific diseases.

Each of these three lines of evidence was evaluated and then considered together in drawing conclusions. The Committee was aware that the mere establishment of a statistical association between the use of tobacco and a disease is not enough. The causal significance of the use of tobacco in relation to the disease is the crucial question. For such judgments all three

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lines of evidence are essential, as discussed in more detail on pages 26–27 of this Chapter, and in Chapter 3.

The experimental, clinical, and pathological evidence, as well as data from population studies, is highlighted in Section B of this Chapter, which in turn refers the reader to specific places in Part II of the Report where this evidence is presented in detail.

In the paragraphs which follow, the Committee has chosen to summarize the results of the seven prospective population studies which, as noted above, constitute only one type of evidence. They illustrate the nature and potential magnitude of the smoking-health problem, and bring out a number of factors which are involved.

Evidence From the Combined Results of Prospective Studies

The Committee examined the seven prospective studies separately as well as their combined results. Considerable weight was attached to the consistency of findings among the several studies. However, to simplify presentation, only the combined results are highlighted here.

Of the 1,123,000 men who entered the seven prospective studies and who provided usable histories of smoking habits (and other characteristics such as age), 37,391 men died during the subsequent months or years of the studies. No analyses of data for females from prospective studies are presently available.

To permit ready comparison of the mortality experience of smokers and non-smokers, two concepts are widely used in the studies—excess deaths of smokers compared with non-smokers, and mortality ratio. After adjustments for differences in age and the number of cigarette smokers and non-smokers, an expected number of deaths of smokers is derived on the basis of deaths among non-smokers. Excess deaths are thus the number of actual (observed) deaths among smokers in excess of the number expected. The mortality ratio, for which the method of computation is described in Chapter 8, measures the relative death rates of smokers and non-smokers. If the age-adjusted death rates are the same, the mortality ratio will be 1.0; if the death rates of smokers are double those of non-smokers, the mortality ratio will be 2.0. (Expressed as a percentage, this example would be equivalent to a 100 percent increase.).

Table 2 presents the accumulated and combined data on 14 disease categories for which the mortality ratio of cigarette smokers to non-smokers was 1.5 or greater.

The mortality ratio for male cigarette smokers compared with non-smokers, for all causes of death taken together, is 1.68, representing a total death rate nearly 70 percent higher than for non-smokers. (This ratio includes death rates for diseases not listed in the table as well as for the 14 disease categories shown.)

In the combined results from the seven studies, the mortality ratio of cigarette smokers over non-smokers was particularly high for a number of diseases: cancer of the lung (10.8), bronchitis and emphysema (6.1), can-

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TABLE 2.[1]—*Expected and observed deaths for smokers of cigarettes only and mortality ratios in seven prospective studies*

Underlying cause of death	Expected deaths	Observed deaths	Mortality ratio
Cancer of lung (162-3) [2]	170.3	1,833	10.8
Bronchitis and emphysema (502, 521.1)	89.5	546	6.1
Cancer of larynx (161)	14.0	75	5.4
Oral cancer (140-8)	37.0	152	4.1
Cancer of esophagus (150)	33.7	113	3.4
Stomach and duodenal ulcers (540, 541)	105.1	294	2.8
Other circulatory diseases (451-68)	254.0	649	2.6
Cirrhosis of liver (581)	169.2	379	2.2
Cancer of bladder (181)	111.6	216	1.9
Coronary artery disease (420)	6,430.7	11,177	1.7
Other heart diseases (421-2, 430-4)	526.0	888	1.7
Hypertensive heart (440-3)	409.2	631	1.5
General arteriosclerosis (450)	210.7	310	1.5
Cancer of kidney (180)	79.0	120	1.5
All causes [3]	15,653.9	23,223	1.68

[1] Abridged from Table 26, Chapter 8, Mortality.
[2] International Statistical Classification numbers in parentheses.
[3] Includes all other causes of death as well as those listed above.

cer of the larynx (5.4), oral cancer (4.1), cancer of the esophagus (3.4), peptic ulcer (2.8), and the group of other circulatory diseases (2.6). For coronary artery disease the mortality ratio was 1.7.

Expressed in percentage-form, this is equivalent to a statement that for coronary artery disease, the leading cause of death in this country, the death rate is 70 percent higher for cigarette smokers. For chronic bronchitis and emphysema, which are among the leading causes of severe disability, the death rate for cigarette smokers is 500 percent higher than for non-smokers. For lung cancer, the most frequent site of cancer in men, the death rate is nearly 1,000 percent higher.

Other Findings of the Prospective Studies

In general, the greater the number of cigarettes smoked daily, the higher the death rate. For men who smoke fewer than 10 cigarettes a day, according to the seven prospective studies, the death rate from all causes is about 40 percent higher than for non-smokers. For those who smoke from 10 to 19 cigarettes a day, it is about 70 percent higher than for non-smokers; for those who smoke 20 to 39 a day, 90 percent higher; and for those who smoke 40 or more, it is 120 percent higher.

Cigarette smokers who stopped smoking before enrolling in the seven studies have a death rate about 40 percent higher than non-smokers, as against 70 percent higher for current cigarette smokers. Men who began smoking before age 20 have a substantially higher death rate than those who began after age 25. Compared with non-smokers, the mortality risk of cigarette smokers, after adjustments for differences in age, increases with duration of smoking (number of years), and is higher in those who stopped after age 55 than for those who stopped at an earlier age.

In two studies which recorded the degree of inhalation, the mortality ratio for a given amount of smoking was greater for inhalers than for non-inhalers.

The ratio of the death rates of smokers to that of non-smokers is highest

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at the earlier ages (40–50) represented in these studies, and declines with increasing age.

Possible relationships of death rates and other forms of tobacco use were also investigated in the seven studies. The death rates for men smoking less than 5 cigars a day are about the same as for non-smokers. For men smoking more than 5 cigars daily, death rates are slightly higher. There is some indication that these higher death rates occur primarily in men who have been smoking more than 30 years and who inhale the smoke to some degree. The death rates for pipe smokers are little if at all higher than for non-smokers, even for men who smoke 10 or more pipefuls a day and for men who have smoked pipes more than 30 years.

Excess Mortality

Several of the reports previously published on the prospective studies included a table showing the distribution of the excess number of deaths of cigarette smokers among the principal causes of death. The hazard must be measured not only by the mortality ratio of deaths in smokers and non-smokers, but also by the importance of a particular disease as a cause of death.

In all seven studies, coronary artery disease is the chief contributor to the excess number of deaths of cigarette smokers over non-smokers, with lung cancer uniformly in second place. For all seven studies combined, coronary artery disease (with a mortality ratio of 1.7) accounts for 45 percent of the excess deaths among cigarette smokers, whereas lung cancer (with a ratio of 10.8) accounts for 16 percent.

Some of the other categories of diseases that contribute to the higher death rates for cigarette smokers over non-smokers are diseases of the heart and blood vessels, other than coronary artery disease, 14 percent; cancer sites other than lung, 8 percent; and chronic bronchitis and emphysema, 4 percent.

Since these diseases as a group are responsible for more than 85 percent of the higher death rate among cigarette smokers, they are of particular interest to public health authorities and the medical profession.

Associations and Causality

The array of information from the prospective and retrospective studies of smokers and non-smokers clearly establishes an association between cigarette smoking and substantially higher death rates. The mortality ratios in Table 2 provide an approximate index of the relative strength of this association, for all causes of death and for 14 disease categories.

In this inquiry the epidemiologic method was used extensively in the assessment of causal factors in the relationship of smoking to health among human beings upon whom direct experimentation could not be imposed. Clinical, pathological, and experimental evidence was thoroughly considered and often served to suggest an hypothesis or confirm or contradict other findings. When coupled with the other data, results from the epidemiologic

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studies can provide the basis upon which judgments of causality may be made.

It is recognized that no simple cause-and-effect relationship is likely to exist between a complex product like tobacco smoke and a specific disease in the variable human organism. It is also recognized that often the coexistence of several factors is required for the occurrence of a disease, and that one of the factors may play a determinant role; that is, without it, the other factors (such as genetic susceptibility) seldom lead to the occurrence of the disease.

The Effects of Smoking: Principal Findings

Cigarette smoking is associated with a 70 percent increase in the age-specific death rates of males. The total number of excess deaths causally related to cigarette smoking in the U.S. population cannot be accurately estimated. In view of the continuing and mounting evidence from many sources, it is the judgment of the Committee that cigarette smoking contributes substantially to mortality from certain specific diseases and to the overall death rate.

Lung Cancer

Cigarette smoking is causally related to lung cancer in men; the magnitude of the effect of cigarette smoking far outweighs all other factors. The data for women, though less extensive, point in the same direction.

The risk of developing lung cancer increases with duration of smoking and the number of cigarettes smoked per day, and is diminished by discontinuing smoking. In comparison with non-smokers, average male smokers of cigarettes have approximately a 9- to 10-fold risk of developing lung cancer and heavy smokers at least a 20-fold risk.

The risk of developing cancer of the lung for the combined group of pipe smokers, cigar smokers, and pipe and cigar smokers is greater than for non-smokers, but much less than for cigarette smokers.

Cigarette smoking is much more important than occupational exposures in the causation of lung cancer in the general population.

Chronic Bronchitis and Emphysema

Cigarette smoking is the most important of the causes of chronic bronchitis in the United States, and increases the risk of dying from chronic bronchitis and emphysema. A relationship exists between cigarette smoking and emphysema but it has not been established that the relationship is causal. Studies demonstrate that fatalities from this disease are infrequent among non-smokers.

For the bulk of the population of the United States, the relative importance of cigarette smoking as a cause of chronic broncho-pulmonary disease is much greater than atmospheric pollution or occupational exposures.

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Cardiovascular Diseases

It is established that male cigarette smokers have a higher death rate from coronary artery disease than non-smoking males. Although the causative role of cigarette smoking in deaths from coronary disease is not proven, the Committee considers it more prudent from the public health viewpoint to assume that the established association has causative meaning than to suspend judgment until no uncertainty remains.

Although a causal relationship has not been established, higher mortality of cigarette smokers is associated with many other cardiovascular diseases, including miscellaneous circulatory diseases, other heart diseases, hypertensive heart disease, and general arteriosclerosis.

Other Cancer Sites

Pipe smoking appears to be causally related to lip cancer. Cigarette smoking is a significant factor in the causation of cancer of the larynx. The evidence supports the belief that an association exists between tobacco use and cancer of the esophagus, and between cigarette smoking and cancer of the urinary bladder in men, but the data are not adequate to decide whether these relationships are causal. Data on an association between smoking and cancer of the stomach are contradictory and incomplete.

The Tobacco Habit and Nicotine

The habitual use of tobacco is related primarily to psychological and social drives, reinforced and perpetuated by the pharmacological actions of nicotine.

Social stimulation appears to play a major role in a young person's early and first experiments with smoking. No scientific evidence supports the popular hypothesis that smoking among adolescents is an expression of rebellion against authority. Individual stress appears to be associated more with fluctuations in the amount of smoking than with the prevalence of smoking. The overwhelming evidence indicates that smoking—its beginning, habituation, and occasional discontinuation—is to a very large extent psychologically and socially determined.

Nicotine is rapidly changed in the body to relatively inactive substances with low toxicity. The chronic toxicity of small doses of nicotine is low in experimental animals. These two facts, when taken in conjunction with the low mortality ratios of pipe and cigar smokers, indicate that the chronic toxicity of nicotine in quantities absorbed from smoking and other methods of tobacco use is very low and probably does not represent an important health hazard.

The significant beneficial effects of smoking occur primarily in the area of mental health, and the habit originates in a search for contentment. Since no means of measuring the quantity of these benefits is apparent, the Committee finds no basis for a judgment which would weigh benefits against hazards of smoking as it may apply to the general population.

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The Committee's Judgment in Brief

On the basis of prolonged study and evaluation of many lines of converging evidence, the Committee makes the following judgment:

Cigarette smoking is a health hazard of sufficient importance in the United States to warrant appropriate remedial action.

B. COMMENTS AND DETAILED CONCLUSIONS

(A Guide to Part II of the Report)

All conclusions formally adopted by the Committee are presented at the end of this section in bold-faced type for convenience of reference. In the interest of conciseness, the documentation and most of the discussion are omitted from this condensation. Together with the tables of contents which appear at the beginning of each chapter in Part II, it is intended as a guide to the Report.

Chemistry and Carcinogenicity of Tobacco and Tobacco Smoke

Condensates of tobacco smoke are carcinogenic when tested by application to the skin of mice and rabbits and by subcutaneous injection in rats (Chapter 9, pp. 143–145). Bronchogenic carcinoma has not been produced by the application of tobacco extracts, smoke, or condensates to the lung or the tracheobronchial tree of experimental animals with the possible exception of dogs (Chapter 9, p. 165).

Bronchogenic carcinoma has been produced in laboratory animals by the administration of polycyclic aromatic hydrocarbons, certain metals, radioactive substances, and viruses. The histopathologic characteristics of the tumors produced are similar to those observed in man and are predominantly of the squamous variety (Chapter 9, pp. 166–167).

Seven polycyclic hydrocarbon compounds isolated from cigarette smoke have been established to be carcinogenic in laboratory animals. The results of a number of assays for carcinogenicity of tobacco smoke tars present a puzzling anomaly: the total tar from cigarettes has many times the carcinogenic potency of benzo(a)pyrene present in the tar. The other carcinogens known to be present in tobacco smoke are, with the exception of dibenzo(a,i)pyrene, much less potent than benzo(a)pyrene and they are present in smaller amounts. Apparently, therefore, the whole is greater than the sum of the known parts. This discrepancy may possibly be due to the presence of cocarcinogens in tobacco smoke, and/or damage to mucus production and ciliary transport mechanism (Chapter 6, p. 61, Chapter 9, p. 144 and Chapter 10, pp. 267–269).

There is abundant evidence that cancer of the skin can be induced in man by industrial exposure to soots, coal tar, pitch, and mineral oils. All of these

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contain various polycyclic aromatic hydrocarbons proven to be carcinogenic in many species of animals. Some of these hydrocarbons are also present in tobacco smoke. It is reasonable to assume that these can be carcinogenic for man also (Chapter 9, pp. 146–148).

Genetic factors play a significant role in the development of pulmonary adenomas in mice. It is possible that genetic factors can influence the smoking habit and the response in man to carcinogens in smoke. However, there is no evidence that they have played an appreciable role in the great increase of lung cancer in man since the beginning of this century (Chapter 9, p. 190).

Components of the gas phase of cigarette smoke have been shown to produce various undesirable effects on test animals or organs. One of these effects is suppression of ciliary transport activity, an important cleansing function in the trachea and bronchi (Chapter 6, p. 61 and Chapter 10, pp. 267–270).

Characterization of the Tobacco Habit

The habitual use of tobacco is related primarily to psychological and social drives, reinforced and perpetuated by the pharmacological actions of nicotine on the central nervous system. Nicotine-free tobacco or other plant materials do not satisfy the needs of those who acquire the tobacco habit (Chapter 13, p. 354).

The tobacco habit should be characterized as an habituation rather than an addiction. Discontinuation of smoking, although possessing the difficulties attendant upon extinction of any conditioned reflex, is accomplished best by reinforcing factors which interrupt the psychogenic drives. Nicotine substitutes or supplementary medications have not been proven to be of major benefit in breaking the habit (Chapter 13, p. 354).

Pathology and Morphology

Several types of epithelial changes are much more common in the trachea and bronchi of cigarette smokers, with or without lung cancer, than of non-smokers and of patients without lung cancer. These epithelial changes are (a) loss of cilia, (b) basal cell hyperplasia, and (c) appearance of atypical cells with irregular hyperchromatic nuclei. The degree of each of the epithelial changes in general increases with the number of cigarettes smoked. Extensive atypical changes have been seen most frequently in men who smoked two or more packs of cigarettes a day.

Women cigarette smokers, in general, have the same epithelial changes as men smokers. However, at given levels of cigarette use, women appear to show fewer atypical cells than do men. Older men smokers have more atypical cells than younger men smokers. Men who smoke either pipes or cigars have more epithelial changes than non-smokers, but have fewer changes than cigarette smokers consuming approximately the same amount of tobacco. Male ex-cigarette smokers have less hyperplasia and fewer atypical cells than current cigarette smokers.

It may be concluded, on the basis of human and experimental evidence, that some of the advanced epithelial hyperplastic lesions with many atypical

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cells, as seen in the bronchi of cigarette smokers, are probably premalignant (Chapter 9, pp. 167–173).

Typing of Tumors.—Squamous and oval-cell carcinomas (Group I of Kreyberg's classification) comprise the predominant types associated with the increase of lung cancer in the male population. In several studies, adenocarcinomas (Group II) have also shown a definite increase, although to a much lesser degree. The histological typing of lung cancer is reliable, but the use of the ratio of histological types as an index of the magnitude of increase in lung cancer is of limited value (Chapter 9, pp. 173–175).

Functional and Pathological Changes.—Cigarette smoke produces significant funtional alterations in the trachea, bronchus, and lung. Like several other agents, cigarette smoke can reduce or abolish ciliary motility in experimental animals. Postmortem examination of bronchi from smokers shows a decrease in the number of ciliated cells, shortening of the remaining cilia, and changes in goblet cells and mucous glands. The implication of these morphological observations is that functional impairment would result.

In animal experiments, cigarette smoke appears to affect the physical characteristics of the lung-lining layer and to impair alveolar (air sac) stability. Alveolar phagocytes ingest tobacco smoke components and assist in their removal from the lung. This phagocytic clearance mechanism breaks down under the stress of protracted high-level exposure to cigarette smoke, and smoke components accumulate in the lungs of experimental animals (Chapter 10, pp. 269–270).

The chronic effects of cigarette smoking upon pulmonary function are manifested mainly by a reduction in ventilatory function as measured by the forced expiratory volume (Chapter 10, pp. 289–292).

Histopathological alterations occur as a result of tobacco smoke exposure in the tracheobronchial tree and in the lung parenchyma of man. Changes regularly found in chronic bronchitis—increase in the number of goblet cells, and hypertrophy and hyperplasia of bronchial mucous glands—are more often present in the bronchi of smokers than non-smokers. Cigarette smoke produces significant functional alterations in the upper and lower airways to the lungs. Such alterations could be expected to interfere with the cleansing mechanisms of the lung.

Pathological changes in pulmonary parenchyma, such as rupture of alveolar septa (partitions of the air sacs) and fibrosis, have a remarkably close association with past history of cigarette smoking. These latter changes cannot be related with certainty to emphysema or other recognized diseases at the present time (Chapter 10, pp. 270–275).

Mortality

The death rate for smokers of cigarettes only, who were smoking at the time of entry into the particular prospective study, is about 70 percent higher than that for non-smokers. The death rates increase with the amount smoked. For groups of men smoking less than 10, 10–19, 20–39, and 40 cigarettes and over per day, respectively, the death rates are about 40 percent, 70 per-

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cent, 90 percent, and 120 percent higher than for non-smokers. The ratio of the death rates of smokers to non-smokers is highest at the earlier ages (40–50) represented in these studies, and declines with increasing age. The same effect appears to hold for the ratio of the death rate of heavy smokers to that of light smokers. In the studies that provided this information, the mortality ratio of cigarette smokers to non-smokers was substantially higher for men who started to smoke under age 20 than for men who started after age 25. The mortality ratio was increased as the number of years of smoking increased. In two studies which recorded the degree of inhalation, the mortality ratio for a given amount of smoking was greater for inhalers than for non-inhalers. Cigarette smokers who had stopped smoking prior to enrollment in the study had mortality ratios about 1.4 as against 1.7 for current cigarette smokers. The mortality ratio of ex-cigarette smokers increased with the number of years of smoking and was higher for those who stopped after age 55 than for those who stopped at an earlier age (Chapter 8, p. 93).

The biases from non-response and from errors of measurement that are difficult to avoid in mass studies may have resulted in some over-estimation of the true mortality ratios for the complete populations. In our judgment, however, such biases can account for only a part of the elevation in mortality ratios found for cigarette smokers (Chapter 8, p. 96).

Death rates of cigar smokers are about the same as those of non-smokers for men smoking less than five cigars daily. For men smoking five or more cigars daily, death rates were slightly higher (9 percent to 27 percent) than for non-smokers in the four studies that gave this information. There is some indication that this higher death rate occurs primarily in men who have been smoking for more than 30 years and in men who stated that they inhaled the smoke to some degree. Death rates for current pipe smokers were little if at all higher than for non-smokers, even with men smoking 10 or more pipefuls per day and with men who had smoked pipes for more than 30 years. Ex-cigar and ex-pipe smokers, on the other hand, showed higher death rates than both non-smokers and current pipe or cigar smokers in four out of five studies (Chapter 8, p. 94). The explanation is not clear but may be that a substantial number of such smokers stopped because of illness.

Mortality by Cause of Death.—In the combined results from the seven prospective studies, the mortality ratio of cigarette smokers was particularly high for a number of diseases. There is a further group of diseases, including some of the most important chronic diseases, for which the mortality ratio for cigarette smokers lay between 1.2 and 2.0. The explanation of the moderate elevations in mortality ratios in this large group of causes is not clear. Part may be due to the sources of bias previously mentioned or to some constitutional and genetic difference between cigarette smokers and non-smokers. There is also the possibility that cigarette smoking has some general debilitating effect, although no medical evidence that clearly supports this hypothesis can be cited (Chapter 8, p. 105).

In all seven studies, coronary artery disease is the chief contributor to the excess number of deaths of cigarette smokers over non-smokers, with lung cancer uniformly in second place (Chapter 8, p. 108).

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For cigar and pipe smokers combined, there was a suggestion of high mortality ratios for cancers of the mouth, esophagus, larynx and lung, and for stomach and duodenal ulcers. These ratios are, however, based on small numbers of deaths (Chapter 8, p. 107).

Cancer by Site

Lung Cancer

Cigarette smoking is causally related to lung cancer in men; the magnitude of the effect of cigarette smoking far outweighs all other factors. The data for women, though less extensive, point in the same direction.

The risk of developing lung cancer increases with duration of smoking and the number of cigarettes smoked per day, and is diminished by discontinuing smoking.

The risk of developing cancer of the lung for the combined group of pipe smokers, cigar smokers, and pipe and cigar smokers, is greater than for non-smokers, but much less than for cigarette smokers. The data are insufficient to warrant a conclusion for each group individually (Chapter 9, p. 196).

Oral Cancer

The causal relationship of the smoking of pipes to the development of cancer of the lip appears to be established.

Although there are suggestions of relationships between cancer of other specific sites of the oral cavity and the several forms of tobacco use, their causal implications cannot at present be stated (Chapter 9, pp. 204–205).

Cancer of the Larynx

Evaluation of the evidence leads to the judgment that cigarette smoking is a significant factor in the causation of laryngeal cancer in the male (Chapter 9, p. 212).

Cancer of the Esophagus

The evidence on the tobacco-esophageal cancer relationship supports the belief that an association exists. However, the data are not adequate to decide whether the relationship is causal (Chapter 9, p. 218).

Cancer of the Urinary Bladder

Available data suggest an association between cigarette smoking and urinary bladder cancer in the male but are not sufficient to support a judgment on the causal significance of this association (Chapter 9, p. 225).

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Stomach Cancer

No relationship has been established between tobacco use and stomach cancer (Chapter 9, p. 229).

Non-Neoplastic Respiratory Diseases, Particularly Chronic Bronchitis and Pulmonary Emphysema

Cigarette smoking is the most important of the causes of chronic bronchitis in the United States, and increases the risk of dying from chronic bronchitis.

A relationship exists between pulmonary emphysema and cigarette smoking but it has not been established that the relationship is causal. The smoking of cigarettes is associated with an increased risk of dying from pulmonary emphysema.

For the bulk of the population of the United States, the importance of cigarette smoking as a cause of chronic bronchopulmonary disease is much greater than that of atmospheric pollution or occupational exposures.

Cough, sputum production, or the two combined are consistently more frequent among cigarette smokers than among non-smokers.

Cigarette smoking is associated with a reduction in ventilatory function. Among males, cigarette smokers have a greater prevalence of breathlessness than non-smokers.

Cigarette smoking does not appear to cause asthma.

Although death certification shows that cigarette smokers have a moderately increased risk of death from influenza and pneumonia, an association of cigarette smoking and infectious diseases is not otherwise substantiated (Chapter 10, p. 302).

Cardiovascular Disease

Smoking and nicotine administration cause acute cardiovascular effects similar to those induced by stimulation of the autonomic nervous system, but these effects do not account well for the observed association between cigarette smoking and coronary disease. It is established that male cigarette smokers have a higher death rate from coronary disease than non-smoking males. The association of smoking with other cardiovascular disorders is less well established. If cigarette smoking actually caused the higher death rate from coronary disease, it would on this account be responsible for many deaths of middle-aged and elderly males in the United States. Other factors such as high blood pressure, high serum cholesterol, and excessive obesity are also known to be associated with an unusually high death rate from coronary disease. The causative role of these factors in coronary disease, though not proven, is suspected strongly enough to be a major reason for taking countermeasures against them. It is also more prudent to assume that the established association between cigarette smoking and coro-

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nary disease has causative meaning than to suspend judgment until no uncertainty remains (Chapter 11, p. 327).

Male cigarette smokers have a higher death rate from coronary artery disease than non-smoking males, but it is not clear that the association has causal significance.

Other Conditions

Peptic Ulcer

Epidemiological studies indicate an association between cigarette smoking and peptic ulcer which is greater for gastric than for duodenal ulcer (Chapter 12, p. 340).

Tobacco Amblyopia

Tobacco amblyopia (dimness of vision unexplained by an organic lesion) has been related to pipe and cigar smoking by clinical impressions. The association has not been substantiated by epidemiological or experimental studies (Chapter 12, p. 342).

Cirrhosis of the Liver

Increased mortality of smokers from cirrhosis of the liver has been shown in the prospective studies. The data are not sufficient to support a direct or causal association (Chapter 12, p. 342).

Maternal Smoking and Infant Birth Weight

Women who smoke cigarettes during pregnancy tend to have babies of lower birth weight.

Information is lacking on the mechanism by which this decrease in birth weight is produced.

It is not known whether this decrease in birth weight has any influence on the biological fitness of the newborn (Chapter 12, p. 343).

Smoking and Accidents

Smoking is associated with accidental deaths from fires in the home.

No conclusive information is available on the effects of smoking on traffic accidents (Chapter 12, p. 345).

Morphological Constitution of Smokers

The available evidence suggests the existence of some morphological differences between smokers and non-smokers, but is too meager to permit a conclusion (Chapter 15, p. 387).

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A clear cut smoker's personality has not emerged from the results so far published. While smokers differ from non-smokers in a variety of characteristics, none of the studies has shown a single variable which is found solely in one group and is completely absent in another. Nor has any single variable been verified in a sufficiently large proportion of smokers and in sufficiently few non-smokers to consider it an "essential" aspect of smoking.

The overwhelming evidence points to the conclusion that smoking—its beginning, habituation, and occasional discontinuation—is to a large extent psychologically and socially determined. This does not rule out physiological factors, especially in respect to habituation, nor the existence of predisposing constitutional or hereditary factors (Chapter 14, p. 377).

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